INTERNAL WAVE MOORING

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LONG-TERM GOALS

The overall goal of this PRIMER program is to assess the feasibility of the operation of a synthetic aperture sonar on the continental shelf. To evaluate the performance of this sonar system, knowledge of the fluctuations of oceanic sound speed, primarily due to internal waves, is needed.

SCIENTIFIC OBJECTIVES

The specific objectives of this project are:

- to describe the internal wave field and associated sound speed fluctuations on the continental shelf--both statistically and by events, and
- to understand the processes involved in the transition of the internal wave field from the deep ocean to the continental slope and shelf.

APPROACH

We deployed a densely-instrumented sub-surface mooring over the continental shelf to record time series of velocity and temperature at vertical and temporal scales appropriate to resolve the internal wave field. A crude estimate of the horizontal correlation of the wave field was made using a reduced set of instruments on two surface buoys within 300 m of the main mooring. The moorings were operating during the PRIMER acoustic observations made by K. Williams, F. Henyey (UW/APL), and S. Stanic (URL). The field work was conducted cooperatively with investigators involved in the ONR Coastal Mixing & Optics program--especially T. Dickey (UCSB), and S. Lentz, A. Plueddemann, S. Andersen (WHOI).

WORK COMPLETED

The moorings were deployed on the shelf in 70 m of water on 9 July 1996 and recovered about 3 months later on 26 Sept 1996. Almost all of the instruments functioned properly, recording data every 2 minutes. A data report has been published (Boyd, Levine, and Gard, 1997) and a CD containing converted data has been released. Preliminary results were presented at several workshops and at The Oceanography Society meeting in Seattle, 1997.

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RESULTS

The 3-month time series captured a variety of different phenomena that span a range of space and time scales. Some examples can be seen in the temperature time series shown here.

Two major storm systems, which were downgraded hurricanes, passed near the mooring site. These storms resulted in significant mixing events (Figure 1). The temperature at 11 m typically cooled during the storms as colder water was entrained from below. During Edouard the temperature as deep as 54 m warmed apparently due to vertical mixing. The change in potential energy due to the passage of Edouard was calculated and compared with expectations from simple bulk models.

Tidal oscillations are prevalent in the temperature at 11 m and are primarily due to the vertical displacement by the internal tide. After the mixing of the upper layer by Bertha and Edouard, the tidal oscillations are much reduced; the internal tide may still exist, but the vertical temperature gradient is much weaker.

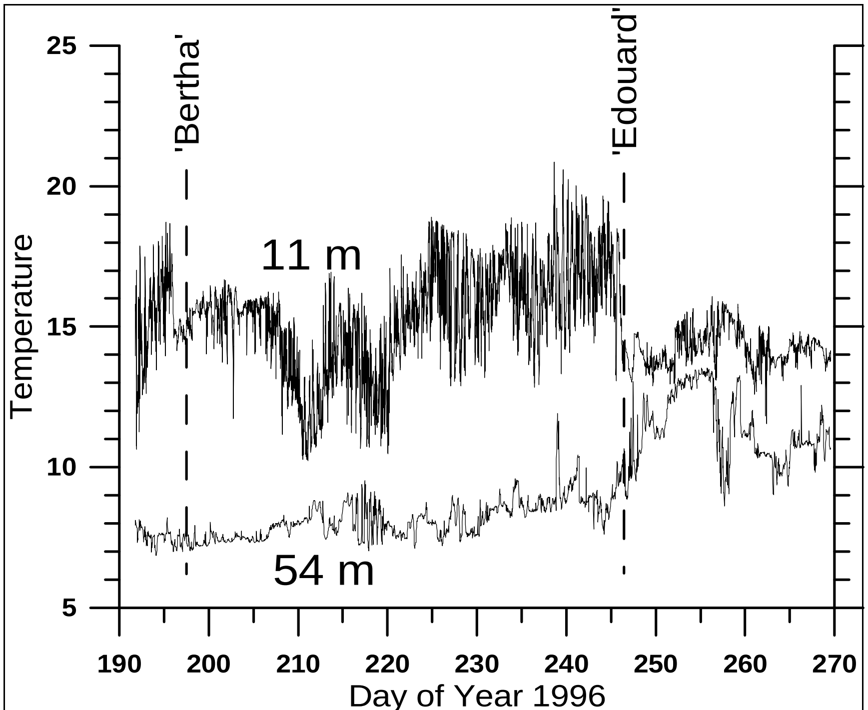

Figure 1. Temperature time series recorded at 11 and 54 m. The arrival times of tropical storms Bertha and Edouard are indicated.

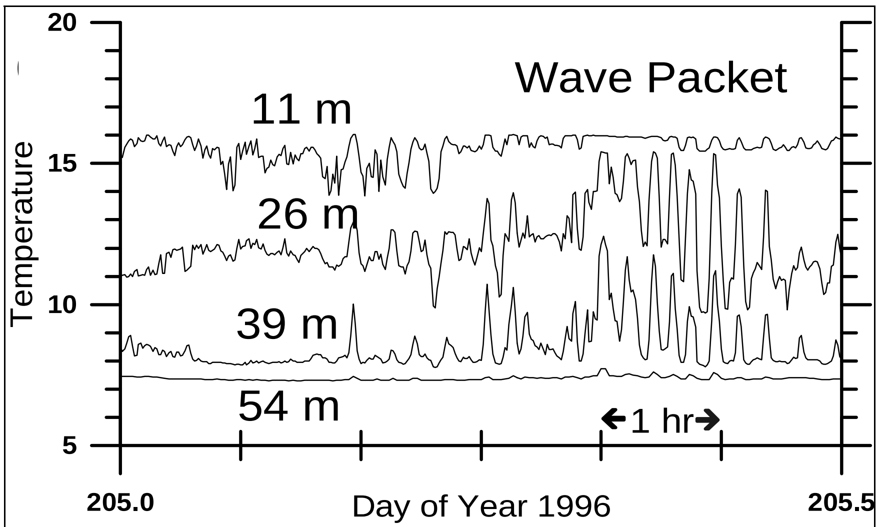

Figure 2. A 12-hour time series of temperature recorded at 4 depths during the passage of a packet of high-frequency internal waves. The packet consists of a series of sharp downward displacement "spikes" which correspond to sharp temperature increases.

High-frequency nonlinear wave packets occur throughout the time series. These packets are generated by the interaction of the barotropic tide with the shelf break. Packets are usually separated by multiples of a tidal period (about 12 hours). A typical example of a wave packet is shown in Figure 2. The wave period is about 12 minutes with vertical displacements reaching 10 m. More will be learned when the complete set of temperature time series (every 3 to 6 m in the vertical) are analyzed in conjunction with the velocity observations (every 4 m).

IMPACT / APPLICATIONS

The measured oceanic variability will be compared with observed acoustic observations and used as input to acoustic models in order to assess the potential performance of synthetic aperture sonar systems on the continental shelf. We will also use the detailed analysis of the internal wave field to provide a framework for creating a climatology of internal waves on the shelf and slope.

TRANSITIONS

The observed variability of the internal wave field will be used as input to the acoustic modeling effort, which ultimately will assess the feasibility of a SAS system in this environment. Defining the internal wave field is also important to those investigators who measured turbulent mixing and optical fluctuations at the same time under related programs.

RELATED PROJECTS

The data from the moorings are being shared with many investigators involved in the Coastal Mixing & Optics program who made complementary observations during summer 1996, including T. Dickey (UCSB), R. Zaneveld, J. Barth, M. Kosro (OSU), S. Lentz, A. Plueddemann, S. Andersen (WHOI). We look forward to participating in joint analysis where appropriate combining our internal wave observations with the optical and turbulence data.

REFERENCES

Boyd, T., M.D. Levine, and S.R. Gard, Mooring observations from the Mid-Atlantic Bight, July-September 1996, Ref. 97-2, Data report 164, Oregon State University, 1997.